



Perspective

Multidisciplinary synthesis of long-term human–ecosystem interactions: A perspective from the Garry oak ecosystem of British Columbia



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ABSTRACT

Many ecosystems of conservation concern owe their unique characteristics to long-term management by indigenous peoples. However, there are serious debates concerning the degree and extent of this influence. We argue that delving into the long-term history of a system by compiling research from multiple disciplines helps ecologists to understand the key drivers of ecosystem structure and dynamics, including the role of humans. We use a case study of the endangered Garry oak ecosystem of southern British Columbia (Canada) to show how considering an extended timeline can reveal surprises that challenge conceptions of the way an ecosystem functions. In this system, ecological experiments have shown that the current dominance of exotic species is not due to competitive superiority, but a result of habitat fragmentation and changes in herbivory and disturbance regimes since European settlement. Historical and ethnographic research point to the purposeful and regular use of fire by the Coast Salish peoples of this region, and land survey records indicate that Garry oak has not always been the prime savannah tree species. Paleoecological studies document the maintenance of open savannah habitat in the late Holocene despite cooler, wetter climatic conditions that favour coniferous forests, suggesting a very long history of indigenous management. Archaeological evidence confirms the prolonged presence of human societies on the landscape. These insights contribute both to improved ecological theory and better restoration strategies, and show that ecosystems created via long-term human management are equally valid targets for conservation as ecosystems that have experienced less human influence.

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Contents

1. Introduction	294
2. The Garry oak ecosystem	294
3. Ecological research reveals the hidden causes of exotic invasions	294
4. Historical ecology: fire on the landscape	296
4.1. Written historical records	296
4.2. Land survey records	296
4.3. The tale of the tree rings	297
5. Digging deeper: paleoecology and archaeology	297
6. Implications for this and other threatened ecosystems	298
7. Conclusion	298
Acknowledgements	299
References	299

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1. Introduction

Ecologists used to believe that the ecosystems of the Americas were “pristine” prior to European arrival, assuming the indigenous peoples had little or no discernible impact (McCann, 1999). More and more we realize this belief was false: indigenous peoples of North and South America affected ecosystems significantly (e.g. Delcourt and Delcourt, 2004; Denevan, 1992; Willis et al., 2004). This realization has required ecologists and conservationists to revise their understanding of the origins and functioning of these ecosystems, and also to question the meaning and goals of ecological restoration (e.g. Allison, 2004).

The challenge is to understand and manage ecosystems that are now greatly fragmented and increasingly dominated by human influence, but that at some point were created and/or maintained by cultural activities. Ecologists and conservationists are faced with key questions regarding the interrelationship between humans and their environment over the long term (see Box 1). The challenges in answering these questions are great, but the potential benefits are great too. A greater understanding of the origins of an ecosystem, its variability over time, and its response to human actions can help us to improve ecological theory, and hence develop more effective management and restoration strategies (Landres et al., 1999).

Box 1: Key questions for understanding human–ecosystem interrelationships

- (1) How pervasive and necessary was/is human management in the creation and/or maintenance of a particular ecosystem state?
- (2) What exactly were/are the human actions involved, their purpose, frequency, and duration?
- (3) What was/is the relative impact of human versus climatic or other non-human-caused change, and how do they interact?
- (4) What was the historical range of variability of the ecosystem?
- (5) Can aboriginal land use practices that were important to the maintenance of ecosystem characteristics we value be modified and used as restoration tools today?

In this paper, we present a multidisciplinary perspective on these questions for the threatened Garry oak savannah ecosystem of southeastern Vancouver Island, Canada. Habitat loss and degradation resulting from a rapidly rising human population over the past several decades is currently the dominant threat to this ecosystem. Yet, an understanding of the history of the ecosystem going back to its beginnings over 8000 years ago is necessary to fully understand its current structure and function, and therefore how best to achieve conservation goals. The construction of this long-term history required a synthesis of information from multiple disciplines, and led to some surprises that fundamentally changed our current understanding of this ecosystem.

The call for increased consideration by ecologists and conservationists of long-term ecosystem dynamics and incorporation of research from disciplines outside ecology is not new (e.g. Briggs et al., 2006; Dearing et al., 2006; Foster et al., 1990, 2003; Rick and Lockwood, 2013; Smith and Boyer, 2012; Swetnam et al., 1999; Szabo, 2010; Willis and Birks, 2006; Willis et al., 2007). However, examples that explicitly weave studies of both historical and contemporary dynamics to yield novel insights are still rare in the ecological literature, in particular examples where the timeline is

extended from thousands of years ago all the way to ecological studies on the scale of only a few years. We use the Garry oak ecosystem as a case study to demonstrate that consideration of such an extended timeline can (1) challenge assumptions about the state of an ecosystem in the past, (2) suggest or refute hypotheses concerning the causes of current ecological patterns, and (3) help identify gaps in understanding at particular temporal and/or spatial resolutions. This example can serve as a model to encourage ecologists and conservationists to delve into the long-term history of other study systems via multidisciplinary synthesis or collaboration.

2. The Garry oak ecosystem

Garry oak (*Quercus garryana*), also called Oregon white oak, ranges from British Columbia to California (Fig. 1). In Canada, it is found only on the southeastern tip of Vancouver Island, some of the nearby Gulf Islands, and in two isolated populations in the lower Fraser Valley of mainland British Columbia (Fig. 1; Fuchs, 2001). It is the only native oak in British Columbia. The term “Garry oak ecosystem” refers to a range of vegetation types along with their associated animal species (Fuchs, 2001), and includes open habitats without significant tree cover. However, the archetype of these ecosystems is the Garry oak savannah, which consists of an open canopy of oak with an understory dominated by native wildflowers and grasses (Fig. 2a). Garry oak ecosystems in British Columbia are restricted to the rainshadow of the Olympic and Vancouver Island Insular Mountains where the climate is drier than the rest of the British Columbia coast (Meidinger and Pojar, 1991).

These open landscapes were attractive to early European settlers, who founded the city of Victoria in the heart of Vancouver Island’s savannahs. Captain George Vancouver himself wrote of “...extensive spaces that wore the appearance of having been cleared by art” (Turner, 1999). Since the establishment of the city in 1843, it is estimated that over 90% of Garry oak savannah has been lost to agriculture, development, and forest infilling (Lea, 2006; Fig. 2c). Calls to preserve the Garry oak itself have been ongoing from the early 1900s, and more recently the tree has become the flagship species in a campaign to restore and conserve the remaining savannahs (Cavers, 2009; GOERT, 2011). The Garry oak ecosystem is now recognized as one of Canada’s most at-risk terrestrial ecosystems, with over 100 associated threatened species (Fuchs, 2001).

Ecologists recognize two broad types of Garry oak vegetation (Roemer, 1993). On flatter areas with deeper soils, a Garry oak “parkland” habitat supports large, stately trees. These ecosystems are generally less moisture-limited and are prone to invasion by conifers like Douglas-fir (*Pseudotsuga menziesii*; Fuchs, 2001). In steeper areas with shallow, drier soils, smaller Garry oak trees present a “scrub oak” type habitat that is not conducive to conifer invasion. Besides habitat destruction, fragmentation and conifer encroachment, the main threat to native biodiversity in Garry oak ecosystems is thought to be the spread of invasive, non-native species (GOERT, 2011; Parks Canada Agency, 2006).

3. Ecological research reveals the hidden causes of exotic invasions

Contemporary ecological research, by which we mean ecological research on the scale of a few years to a decade, has mainly focused on the impact of exotic plant species. Many of the rare species are native wildflowers that thrive in sunny, open savannah conditions, but seem to be easily outcompeted by exotic grasses and shrubs (Fig. 2b). As of the late 1960s, introduced plants were already so firmly established in many Garry oak sites as to be part of the core of species defining the community (Roemer, 1972).

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